The New Comparative Economic History

Essays in Honor of Jeffrey G. Williamson

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3 Did European Commodity Prices Converge during 1500–1800?

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Until recently, the dominant view of the European economy during the early modern era was that it was unable to generate long-term economic growth. This interpretation, as articulated by Wilhelm Abel, Michael Postan, Emmanuel Leroy Ladurie, and others, was based, at least in part, on the available evidence for stagnating land productivity and urban real wages. It was also consistent with the prevailing interpretations of the Industrial Revolution. During the last two decades, however, this picture of the stagnant economy that supposedly preceded the Industrial Revolution began to change. The new and downwardly revised estimates of per capita income increases for the eighteenth and early nineteenth centuries implied higher levels of per capita income for the earlier period. In addition, economic historians of the early modern period began to point out that the industrialization of the late eighteenth and early nineteenth centuries was made possible by structural changes that had taken place earlier. The volume of European trade increased steadily in the centuries leading up to the Industrial Revolution. Increases in agricultural productivity, urbanization, national patterns of specialization, the emergence and development of regional, national, and international trade networks have been cited among the important changes that facilitated the rises in income or so-called Smithian growth in the early modern era, or at the very least, made faster growth possible during the era of the Industrial Revolution (de Vries 1994; Persson 1988; van Zanden 1999; 2002).

This recent literature and the findings on the early modern era point to market integration as one of the key processes inducing structural change in early modern Europe. Since the contribution of technological innovation remained limited, according to this view, improvements in productivity were generated by the development of trade between previously distinct markets and the requirements of an interregional and increasingly international division of labor. In short, various types of market integration have been considered one of the key characteristics of Europe before the Industrial Revolution.

Although maritime trade and overseas discoveries have often loomed large in explanations of European ascendancy and economic growth in the early modern era, the extent to which long-distance markets inside Europe were integrated remains to be explored. As Federico and Persson emphasize in chapter 4, examining market integration and its consequences in a variety of contexts has been a central theme in Jeffrey G. Williamson's lifelong research agenda. Following his lead, we explore in this study the extent to which one may speak of integration between selected long-distance markets across Europe during the early modern era. We utilize annual price data for identical commodities from Istanbul in the Ottoman Empire, Modeno in Italy, Madrid and Barcelona in Spain, western Holland, southern England, Paris, Vienna, and Sopron in Hungary to examine whether there was price convergence between long-distance markets in the Mediterranean and central and northwestern Europe for the period 1500–1800. Our list of commodities includes wheat, which has been studied in relation to this question for other periods and regions, and other commodities such as olive oil, rice, honey, sugar, soap, meat, and butter. There is no question that these markets were linked during the early modern era, and trade did take place among them though not always on a regular basis. This inquiry should help us learn more about the extent and the limits of market integration in early modern Europe.

Market Integration in Early Modern Europe, 1500–1800

Market integration can be defined as the opening and development of trade between previously autonomous markets and their integration into a single operative entity or a single division of labor. The concept carries with it important implications for structural change as the fabric of each economy is tailored to the requirements of an interregional and increasingly international division of labor. Improvements in productivity are thus generated by the territorial expansion of the division of labor and a reallocation of resources within regions or national economies. For market integration to have an independent influence on an economy, two conditions must be fulfilled: (1) trade-creating forces must change domestic commodity prices; and (2) changes in domestic commodity prices must induce a reshuffling of resources. While price convergence is not a sufficient reason for market integration, and it is possible to think about causes of price convergence without market integration, such as large-scale climatic changes, without the tendency for prices to converge it is clear that the process of market integration loses much of its force (Jacks 2000).

Sources of Market Integration

The causes of market integration and price convergence can be grouped under two headings. One important cause is technological change, bringing about decline in transportation costs and related costs associated with storage and spoilage. The decline in freight costs is usually seen as the most important cause of trade growth and price convergence in international and intercontinental markets during the nineteenth century, for example. A similar case can be made for the importance of railroads in bringing about price convergence in overland transportation. If the growth in trade in the early modern era had a techological source, it was the introduction, in the latter part of the fifteenth century, of the three-masted, larger trading vessel, which lowered costs of transportation and allowed trading over greater distances. Such technological changes remained limited after the fifteenth century, however (Rosenberg and Birdzell 1986, 71–96).

In fact, while some economic historians emphasize the importance of market integration and price convergence, others point out that little or no market integration took place and price differentials persisted throughout the early modern era. These authors argue that the admittedly fragmentary evidence on freight rates within Europe during the early modern era does not point to significant decreases in transportation costs. Freight rates in Europe appear to have moved together with commodity prices from the fourteenth century until the end of the eighteenth. Freight charges in the mid-eighteenth century were only slightly lower than their levels in the best years of the high Middle Ages in both nominal and real terms. On the basis of the available data on freight rates, then, one cannot make a case for a premodern European transport revolution led by technical innovations. Productivity gains rooted in better techniques appear to have played only a minor role in the growth of trade in these centuries (Unger 1983; Allen and Unger 1990; Menard 1991).

The literature on market integration may have paid too much attention to transportation costs and not enough to other factors. Even for the nineteenth century, for which there is strong evidence of declining transportation costs, that evidence can explain only part of the observed decline in price differentials (North 1958; Harley 1988; Mohammed and

Willliamson 2003; Jacks 2004; Persson 2004). The second set of causes for market integration and price convergence is the removal or lowering of a wide range of institutional and other barriers. The presence of national borders, or more generally of different jurisdictions, was often an important barrier or the source of a variety of barriers. Not only tariffs and other policy instruments but payments mechanisms, monetary regimes, and interstate conflict need to be included under this heading.

In an important recent study Epstein (2000, 38–72) emphasizes that in late medieval and early modern Europe, market structures that determined regional growth paths depended upon the complex social, economic, and political struggles between sovereigns, feudal lords, cities, and rural communities, and could differ significantly between regions. In grains, for example, jurisdictional fragmentation was the main cause of price volatility. The decline of predatory states and political centralization increased domestic stability and reduced coordination failures between markets. Epstein cites empirical evidence from different parts of western Europe for 1300–1650 indicating that even though transportation costs did not decline significantly, market integration as measured by price dispersion did take place. Innovations that reduce transaction costs by increasing mobility of capital, lowering information costs (e.g., bills of exchange or manuals), or spreading risk (e.g., marine insurance) can also be included under this heading. Epstein concludes that premodern Smithian growth, which was a function of market integration, depended ultimately on the progress of political integration and institutional change rather than on technical change in the period from the Black Death to the Industrial Revolution.[1]

Long-Distance vs. Regional and National Markets

A large part of the institutional changes that Epstein observes for early modern Europe concern regional or short- and medium-range trade. In fact, it is not clear whether the political and institutional changes he emphasizes would apply to long-distance and international trade around Europe and beyond before the nineteenth century. For example, trade inside the Mediterranean was often combined with raiding and freebooting during the early modern era. Moreover, these activities could not have been carried out in isolation. Knowledge of these activities, contributions to their conduct, and profits from their success must have been widely shared, directly or indirectly. Maritime trade was thus at once a major field of economic growth and a field resistant to political control (Rosenberg and Birdzell 1986, 92–96). It may be useful to make a distiction

between short- and medium-range trade, on the one hand, and long-distance trade, on the other, when discussing market integration and Smithian growth in early modern Europe. Maritime trade and overseas discoveries have often loomed large in explanations of the late medieval recovery and European ascendancy, and there is often a temptation in the literature to exaggerate the importance of overseas trade in the early modern era. In fact, there were other, much less dramatic sources of market growth that tend to be neglected, such as rise in population, rise in incomes, urbanization, and growth in interurban trade.

For this reason, it is not clear whether foreign markets grew faster than domestic markets during the early modern era. In fact, until the nineteenth century domestic trade was much more important than international trade for most European countries. The volumes of long-distance maritime trade and international long-distance trade were still small in comparison to domestic trade and overland trade, and they were all sharply lower than the levels reached at the end of the long nineteenth century.

Regional Differentiation within Europe?

One may take a more nuanced perspective, of course. While it is clear that most of Europe did not become engrossed in a complete and overarching system of markets, some regions within the continent were becoming more integrated within themselves and perhaps among one another during the early modern era. Not all regions of Europe were influenced in the same manner or to the same extent by the institutional changes. With respect to long-distance trade as well as domestic trade, the experience of northern and northwestern Europe was very different than that of southern and eastern Europe (de Vries 1976, 160–164). For example, there is evidence that the wheat markets in the Baltic–North Sea region showed a tendency toward greater integration, especially during the first half of these three centuries until 1650, and these gains were not reversed after 1650 (Jacks 2000). Similarly, Granger and Elliot (1967) have argued that England began to constitute a national market in wheat by the early eighteenth century. On the other hand, raiding and freebooting inhibited Mediterranean trade as late as the eighteenth century.

Evidence from European Intercontinental Trade

Another reason for the recent rise in interest in the history of market integration is the current wave of globalization and the studies by economists and economic historians of earlier episodes of globalization. Some historians have argued that the discovery of the Americas and the oceanic route to Asia integrated the continental markets and ushered in a new and global era beginning around 1500. O'Rourke and Williamson (2002a; 2002b) have explored whether there occurred an earlier episode of globalization after the voyages by Columbus and Vasco da Gama. O'Rourke and Williamson define globalization as commodity market integration and emphasize that because an increase in trade volume may be due to shifts in demand or supply curves, the best way to gauge that process is to measure the extent to which prices of the same commodities converged over time worldwide. After studying a large set of prices of commodites subject to intercontinental trade, however, they find no price convergence in intercontinental markets in the three centuries before 1800. In the absence of any decline in transportation costs or in human-made barriers to trade such as tariffs or trade monopolies, they conclude that the increases in European incomes was the most important cause of the intercontinental trade boom during the early modern era.

It is interesting that O'Rourke and Williamson observe no price convergence during a period for which Epstein observes significant reductions in price dispersion. It is worth noting, however, that spatially speaking, these studies are examining market integration at different ends of the spectrum. While Epstein focuses on regional, short- to medium-range trade, O'Rourke and Williamson examine intercontinental trade.

There is no doubt that the concept of market integration remains highly useful for understanding long-term change in early modern Europe. Determining the extent and limits of market integration is very important for further understanding the economic changes in early modern Europe. At the same time, however, this review of the literature suggests that a more nuanced, more disaggregated view of market integration is necessary for making better sense of these trends. In what follows, we do not focus on European intercontinental trade or domestic trade but explore the extent to which market integration applied to long-distance and international trade within Europe.

Statistical Tests and Results

In its simplest form, the theory of market integration is distilled into the so-called law of one price (LOOP). As intermarket trade commences, any observed differentials in the prices of goods will tend to decline and eventually disappear subject to transportation and institutional costs. Since demand or supply curves may be shifting in the meantime, the only irrefutable evidence that market integration is taking place is not the rise in trade volumes but a decline in price differentials or in the dispersion of prices, or what might be called commodity price convergence. The simplicity of the theory of market integration, however, conceals the difficulties in empirical measurement. In the literature on historical and contemporary commodity markets, there have been numerous proposals for the correct measure of market integration.

The traditional approach to market efficiency looks at the correlation of prices or the speed of adjustments to an equilibrium price differential between markets in bilateral trade. The latter approach makes the determination of equilibrium differentials quite easy: price differences shall not exceed transport and transaction costs (including tariffs), and prices must adjust to that equilibrium. However, arbitrage in the world economy is normally multilateral, and therefore bilateral LOOP might not hold for markets when they do not trade with each other. Nonetheless, they can still be integrated by trading with a common third market, although the speed of adjustment may depend on whether they trade directly with another market or indirectly through a common third market.

We are now in a position to directly test for market integration in long-distance markets across Europe in the early modern period. We utilize annual price data for identical commodities from Istanbul in the Ottoman Empire, Modeno in Italy, Madrid and Barcelona in Spain, western Holland, southern England, Paris, Vienna, and Sopron in Hungary for the period 1500–1800. These annual series were obtained from a variety of sources.[2] These cities or regions were all linked to each other by maritime trade during the early modern era. Our commodities include wheat, olive oil, rice, honey, sugar, soap, meat, and butter (figure 3.1). Six of these eight commodities were subject to long-distance maritime trade in the early modern era, although there was less trade in the last two, meat and butter, during the early modern era. Nonetheless, we chose to include them in our study.

Most if not all studies of early modern intra-European market integration have looked at wheat.[3] We are able to examine market integration in seven additional commodities. Clearly, there must have been some correlation between wheat and other commodities as transportation costs, trade policies, and more generally the institutional environment changed together in a given location. At the same time, however, there are many reasons for variations in market integration across commodities because of variations in transportation technology and trade policies. Thus, studying other commodities as well as wheat may allow us new insights.

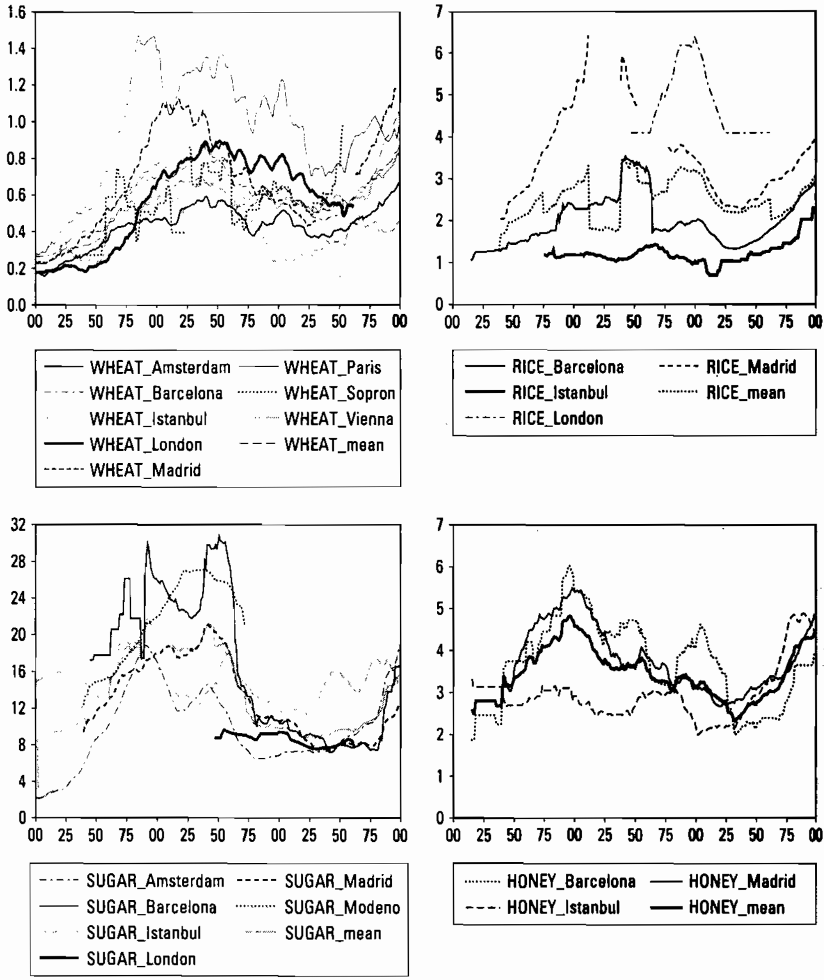

Figure 3.1
Commodity prices, 1500–1800.

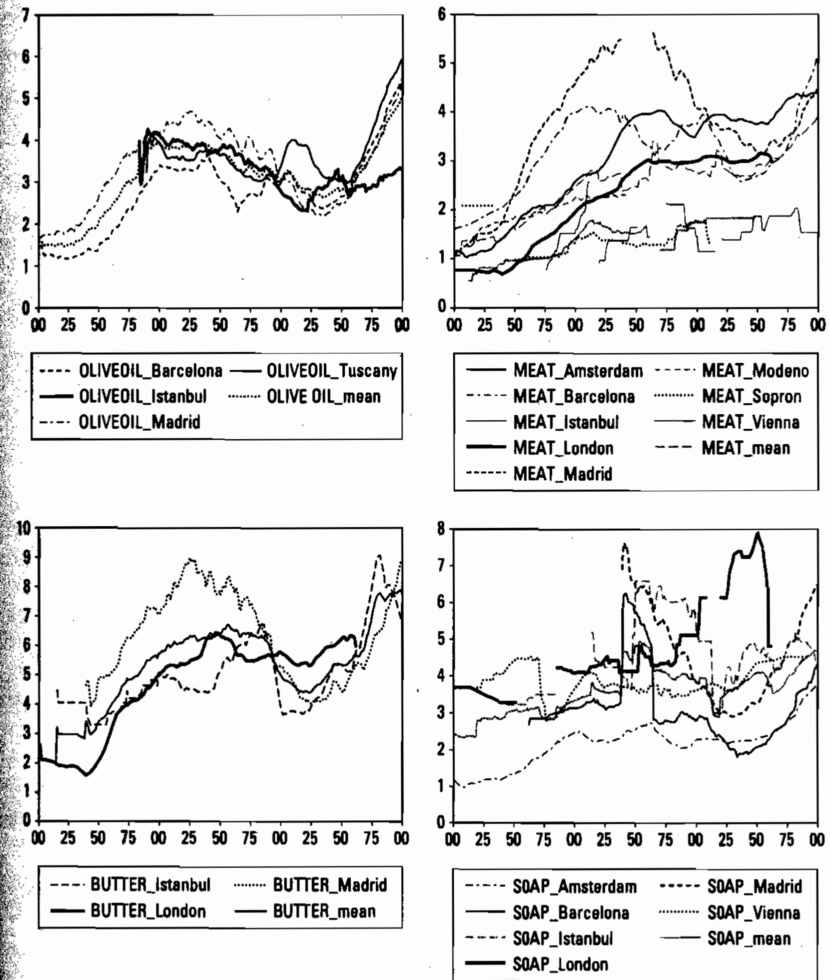

Figure 3.1
(continued)

Standard weight and monetary units are adopted by converting all prices to grams of silver per metric unit. In addition, 25-year moving averages are used in the analysis, for two reasons. First, there are large fluctuations in agricultural prices owing to weather-related crop failures. The procedure of taking moving averages of available data gives a relatively smooth series. Since the ultimate goal is to study long-term tendencies rather than annual changes, averaging would be an appropriate method. Second, a large number of observations are missing in some of the price series. Taking moving averages helps to create a relatively continuous series comparable to others (figure 3.1). In most cases, prices move rather closely, with a positive trend and some spikes. However, this does not really mean there is convergence of prices.

Coefficient of Variation

One frequently used measure of convergence in prices is the decrease in the coefficient of variation of prices.[4] If relative prices stay the same, the coefficient of variation stays the same. On the other hand, if prices converge, both the standard deviation and the coefficient of variation decrease. A statistical test for this decrease may be performed by testing for a unit root.

Figure 3.2 provides the coefficient of variation for each of the eight commodities. For wheat we were able to use data for all eight cities, namely Amsterdam (A), Barcelona (B), Istanbul (I), London (L), Madrid (M), Paris (P), Sopron (S), and Vienna (V) (see figure 3.1). On the other hand, annual price data were available for four cities for rice, six cities for sugar, three cities for honey, four cities for olive oil, eight cities for meat, three cities for butter, and five cities for soap. The coefficient of variation for each commodity is based on the number of cities for which data are available. There is also the problem of missing annual observations, which may create difficulties in interpreting results. The coefficients of variation are actually calculated with data from fewer cities for some years because of this problem. We have added a ninth, combined, commodity to this panel by weighting the coefficient of variation of each commodity by the number of cities for which data were available, namely, the coefficient of variation of wheat by eight, rice by four, and so on.

Is there a negative trend in the coefficient of variation, or is it relatively stable over the period under study? Rather than simply follow the value of this coefficient (increase or decrease) over time, we prefer to answer this question formally, with the help of unit root tests, which look for a stochastic trend in a series. These tests are more restrictive than following the value of the cofficient of variation over time because they look for a permanent trend. In testing for the presence of a unit root (nonstationary) in the coefficient of variation, it is a good idea to use more than one method because unit root tests are asymptotic tests. Accordingly, we have used the augmented Dickey-Fuller (1979) ADF, Phillips-Perron (1988) PP, and Kwiatkowski et al. (1992) KPSS tests. The last test differs from the other two in that the series is assumed to be trend-stationary under the null.[5]

Summary results of the three tests on the coefficient of variation are presented in table 3.1. In the case of wheat, according to the ADF test, the coefficient of variation is a stationary series at the 10 percent significance level. The null hypothesis of a nonstationary series can be rejected at the 10 percent level. Therefore, the coefficient of variation is statistically steady, indicating no convergence in prices in eight cities. A similar result is obtained using the PP test: the null hypothesis of a nonstationary series can be rejected at the 10 percent level, indicating no convergence in prices in eight cities. In the KPSS test, the null hypothesis is "stationary" and the rejection of the null would indicate that there is convergence. Our coefficient of variation of wheat prices in eight cities is stationary at the 10 percent significance level. The null hypothesis cannot be rejected at the 10 percent level. Therefore, there is no convergence in prices. In other words, in the case of wheat all three tests indicate no convergence at the 10 percent significance level.[6]

As summarized in table 3.1, all three tests indicate convergence in rice, olive oil, meat, and soap prices but no convergence in prices of honey at the 10 percent level. On the other hand, conflicting results are obtained in the tests on prices of sugar and butter. According to the ADF and PP tests, sugar prices are stationary at the 1 percent level, indicating no convergence. Yet the KPSS test rejects the hypothesis that sugar prices are stationary at the 5 percent level, indicating convergence. The price of butter is nonstationary at the 10 percent level according to the ADF test, indicating convergence. This series is stationary at the 10 percent level according to the PP test, indicating no convergence. It is nonstationary, indicating convergence, according to the KPSS, indeed a very strong rejection of the null.[7]

The case of sugar may deserve additional attention. The sharp decline in the coefficient of variation of sugar during the sixteenth century (figure 3.2) suggests a story similar to that of O'Rourke and Williamson (2005)

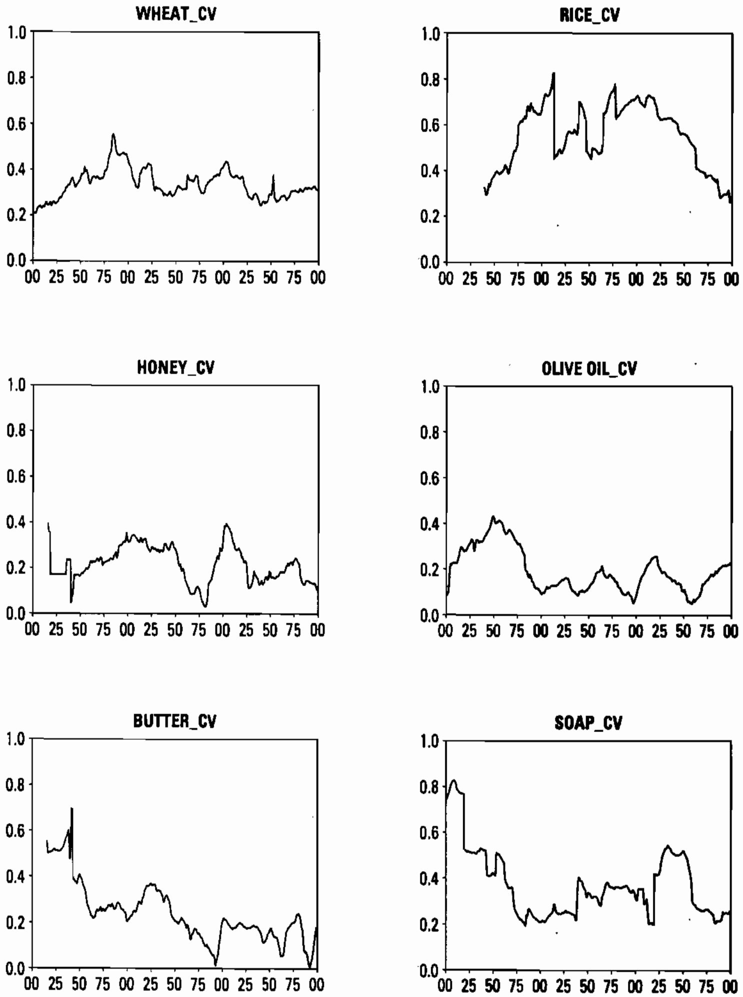

Figure 3.2
Coefficient of variation of prices, 1500–1800.

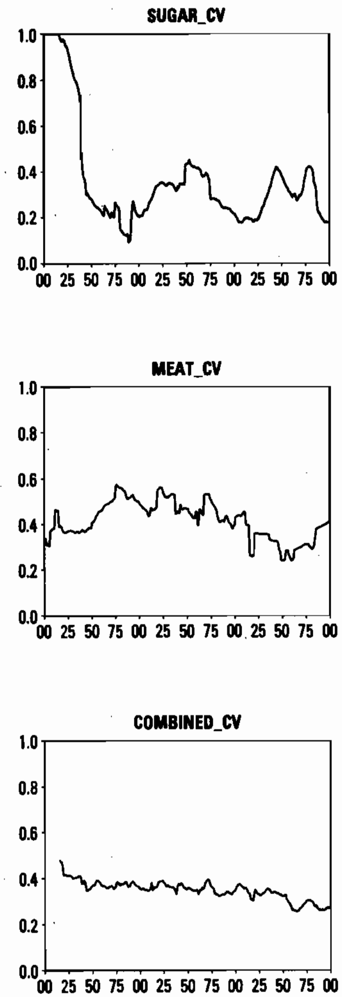

Figure 3.2
(continued)

Table 3.1
Unit Root Tests for Coefficient of Variation

CV	ADF	Test Result	Implied Conclusion with 90% Level of Confidence
Wheat	−2.59	nonstationary rejected at the 10 percent level	no convergence
Rice	−1.69	nonstationary cannot be rejected at the 10 percent level	convergence
Sugar	−3.40	nonstationary rejected at the 1 percent level	no convergence
Honey	−2.80	nonstationary rejected at the 10 percent level	no convergence
Olive oil	−1.67	nonstationary cannot be rejected at the 10 percent level	convergence
Meat	−2.05	nonstationary cannot be rejected at the 10 percent level	convergence
Butter	−2.37	nonstationary cannot be rejected at the 10 percent level	convergence
Soap	−2.40	nonstationary cannot be rejected at the 10 percent level	convergence
Combined CV	−2.85	nonstationary rejected at the 10 percent level	no convergence
CV	**PP**		
Wheat	−2.58	nonstationary rejected at the 10 percent level	no convergence
Rice	−1.70	nonstationary cannot be rejected at the 10 percent level	convergence
Sugar	−3.45	nonstationary rejected at the 1 percent level	no convergence
Honey	−2.99	nonstationary rejected at the 5 percent level	no convergence
Olive oil	−1.83	nonstationary cannot be rejected at the 10 percent level	convergence
Meat	−2.11	nonstationary cannot be rejected at the 10 percent level	convergence
Butter	−2.62	nonstationary rejected at the 10 percent level	no convergence
Soap	−2.50	nonstationary cannot be rejected at the 10 percent level	convergence
Combined CV	−2.92	nonstationary rejected at the 5 percent level	no convergence

Table 3.1
(continued)

CV	KPSS		
Wheat	0.28	stationary cannot be rejected at the 10 percent level	no convergence
Rice	0.36	stationary rejected at the 10 percent level	convergence
Sugar	0.48	stationary rejected at the 5 percent level	convergence
Honey	0.27	stationary cannot be rejected at the 10 percent level	no convergence
Olive oil	0.80	stationary rejected at the 1 percent level	convergence
Meat	0.80	stationary rejected at the 1 percent level	convergence
Butter	1.37	stationary rejected at the 1 percent level	convergence
Soap	0.52	stationary rejected at the 5 percent level	convergence
Combined CV	1.65	stationary rejected at the 1 percent level	convergence

on the impact of Vasco da Gama's voyage on European pepper markets. As was the case with pepper, this was a one-time event, however. European sugar prices did not show any further convergence after the sixteenth century. For this reason, we cannot accept the convergence hypothesis for the early modern era as a whole. Two of the three tests indicate no convergence.

Finally, the combined coefficient of variation, which is a weighted average of coefficient of variations of individual commodity prices with number of cities as weights, can perhaps be taken as an indicator of the aggregate trend in the sample. Two out of three of the tests indicate no convergence for this combined coefficient. According to the ADF and PP tests, a unit root in the combined coefficient of variation is rejected at the 5 percent level, indicating no convergence.[8] On the other hand, the KPSS test rejects stationarity at the 1 percent level, indicating convergence. These are very strong but contradictory results. It is also interesting that the combined coefficient of variation does not show large fluctuations over time. On the basis of the combined coefficient of variation in figure 3.2, it is not possible to identify subperiods when the tendency for convergence was stronger and subperiods when the tendency was in the opposite direction.

In short, the results based on coefficient of variation are mixed. There is convergence in prices of rice, olive oil, meat, and soap, and no convergence in prices of wheat and honey. There are conflicting results on prices of sugar and butter, leaning toward convergence (two out of three tests) in prices of butter and no convergence in prices of sugar. The combined coefficient of variation of prices also indicates no-convergence in two out of three tests.

Cointegration of Prices

Recently, there has been a resurgence of the study of convergence largely because of the issues related to the European Economic and Monetary Union (EMU), where member and candidate countries are expected to satisfy certain criteria associated with targets such as inflation, interest rates, budget deficits and debt. A number of methods have been introduced to tackle this problem. As the convergence in EMU is an ongoing process, it necessitates the use of several related concepts such as long-term convergence, catching up, and common trend (Bernard and Durlauf 1995; 1996; Oxley and Greasley 1995; Greasley and Oxley 1997; Camarero, Esteve, and Tamarit 2000). However, since we are dealing here with a process that has been completed, the problems are not as complicated as the ones faced by those studying the EMU.

Bernard and Durlauf (1995; 1996) define long-run convergence between two countries if the long-term forecasts of the prices are equal sometime in the future given the information at present.[9] This definition is satisfied if the difference in prices is a stationary process with mean zero (Camarero, Esteve, Tamarit 2000). It is possible to use the Engle and Granger (1987) cointegration methodology to see if two prices move toward a long-run equilibrium.[10] The test is applied to residuals from a regression of price in the first city on the price in the other city, with the unit coefficient. The Dickey-Fuller unit root test may then be used.[11]

Tests for cointegration of prices are conducted using two price series at a time. As summarized in table 3.2, in the case of wheat we begin with a regression of wheat prices in Amsterdam on wheat prices in Barcelona with a restriction on the slope coefficient (equaling 1). The Dickey-Fuller unit root test is then applied to residuals from this regression. In this case, the null hypothesis of a nonstationary series cannot be rejected at the 10 percent level.[12] We therefore conclude that wheat prices in Amsterdam and wheat prices in Barcelona are not cointegrated. They do not have a long-run equilibrium, hence indicating no-convergence. In fact, among the wheat pairs, only Amsterdam and Vienna are cointegrated, indicating convergence at the 5 percent level. There is no convergence in the prices of other pairs of cities in the wheat sample.

Similarly, based on the Engle and Granger (1987) methodology, we find no convergence among any pairs of cities in prices of rice, honey, olive oil, meat, and butter. On the other hand, there is convergence in sugar

Table 3.2
Tests for Cointegration of Prices

Wheat	Wheat Barcelona	Wheat Istanbul	Wheat London	Wheat Madrid	Wheat Paris	Wheat Sopron	Wheat Vienna
Wheat Amsterdam	−0.85	−1.36	−1.05	−0.87	−2.03	−1.68	−2.96[a]
Wheat Barcelona	n	0.38	−1.31	−1.49	−1.61	−1.23	−2.11
Wheat Istanbul	n		−0.199	0.97	−1.65	−0.03	−1.05
Wheat London	n			−0.58	−1.93	−0.46	−1.56
Wheat Madrid	n				−1.15	−0.34	−1.51
Wheat Paris	n					−0.64	−2.06
Wheat Sopron	n						−2.54
Rice		**Rice Istanbul**	**Rice London**	**Rice Madrid**			
Rice Barcelona		−1.81	−2.11	1.56			
Rice Istanbul			−1.14	0.20			
Rice London				−1.22			
Sugar	**Sugar Barcelona**	**Sugar Istanbul**	**Sugar London**	**Sugar Madrid**	**Sugar Modeno**		
Sugar Amsterdam	−1.13	−0.39	−1.82	−0.11	−1.28		
Sugar Barcelona		−1.57	−4.44[b]	−2.06	−1.67		
Sugar Istanbul			−1.12	−1.21	−1.30		
Sugar London				−3.66[a]	3.13[c]		
Sugar Madrid					−1.38		

Table 3.2
(continued)

Honey	Honey Istanbul	Honey Madrid
Honey Barcelona	−1.52	−1.57
Honey Istanbul		−1.20

Olive Oil	Olive Oil Istanbul	Olive Oil Madrid	Olive Oil Tuscany
Olive oil Barcelona	1.47	−0.83	−2.60
Olive oil Istanbul		0.17	−0.07
Olive oil Madrid			−0.79

Meat	Meat Barcelona	Meat Istanbul	Meat London	Meat Madrid	Meat Modeno	Meat Sopron	Meat Vienna
Meat Amsterdam	−1.23	1.14	−2.05	−0.76	2.55	−0.51	−1.49
Meat Barcelona		−1.03	−0.99	−2.51	−0.81	−1.46	−0.82
Meat Istanbul			0.72	−1.55	0.49	−1.47	−1.92
Meat London				−0.98	1.45	0.01	−1.02
Meat Madrid					0.15	−1.21	−1.32
Meat Modeno						−2.68	−1.77
Meat Sopron							−1.11

Butter	Butter London	Butter Madrid
Butter Istanbul	−2.20	−1.24
Butter London		−1.15

Soap	Soap Barcelona	Soap Istanbul	Soap London	Soap Madrid	Soap Vienna
Soap Amsterdam	−2.21	−2.07	−1.32	−5.31[b]	−1.63
Soap Barcelona		−2.23	−1.33	−1.55	−2.07
Soap Istanbul			−1.72	−2.73	−2.37
Soap London				−2.25	−0.70
Soap Madrid					−4.01[b]

Notes:
a. Significant at the 5 percent level.
b. Significant at the 1 percent level.
c. Significant at the 10 percent level.

Table 3.3
Number of Cointegrating Equations according to the Johansen Test

	Trace Statistic	Max-Eigen Statistic	No. of Observations	No. of Cities
Wheat	3	3	86	8
Rice	1	0	87	4
Sugar	4	3	24	6
Honey	1	0	256	3
Olive oil	1	1	210	4
Meat	5	2	52	8
Butter	0	0	218	3
Soap	2	2	109	6

and soap prices in some cities. For example, sugar prices in Barcelona and London (at the 1 percent significance level), London and Madrid (at the 5 percent level), and London and Modeno (at the 10 percent level) are cointegrated, indicating convergence. Soap prices in Amsterdam and Madrid, and in Madrid and Vienna, are cointegrated at the 1 percent level, indicating convergence. It is clear from these results that based on the cointegration methodology strong support for convergence of prices does not exist in the sample of eight cities.

We also used the Johansen methodology to test for convergence. The technique introduced by Johansen (1988) allows for multivariate systems and is more general than the Engle-Granger (1987) single equation and two-step methodology. This technique is used to determine the number of cointegrating equations—the number of long-run equilibrium relations.[13] Since the method requires data for all cities for the same period, total number of observations available is not 301 but much less in many cases. According to the Johansen technique, there is no convergence in prices of rice, butter, and honey (table 3.3). On the other hand, there is a possible long-run equilibrium (convergence) for prices of wheat, olive oil, soap, sugar, and meat. However, findings on meat and sugar are based on a small number of observations (52 and 24, respectively) and therefore not sufficiently reliable.

We end this section with an overview of the results of our tests. The coefficient-of-variation methodology yielded mixed results. The three tests agree that there is convergence in four commodities and no convergence in two. They also yield contradictory results in two commodities and in the combined coefficient of variation. The Engle-Granger cointegration methodology, on the other hand, indicates no convergence in most of the cases with the exception of just one pair of cities in wheat (Amsterdam and Vienna), three pairs in sugar (Barcelona and London, London and Madrid, and London and Modeno), and two pairs in soap (Amsterdam and Madrid, and Madrid and Vienna). Finally, according to the multivariate cointegration technique of Johansen, there is no convergence in prices of rice, butter, and honey, and there is convergence in prices of wheat, olive oil, and soap.

The differences in the test results require some elaboration. Since the Engle-Granger cointegration methodology involves two cities at a time, it is probably less affected by data issues. In contrast, the coefficient of variation is calculated using data on all cities. There may be missing data, with the exception of wheat prices, that can affect these calculations. For example, a city with a high price may have missing values toward the end of the period. This will give a misleading impression that prices are converging. On the other hand, Engle-Granger cointegration tests, as implemented here, have the restriction that prices be equal at equilibrium. This may be quite restrictive, if compared to the method using the coefficient of variation. These differences may have led to the differences in the test results.

While there are differences in the results based on alternative methodologies, including the panel unit root tests conducted in an earlier version of the chapter, we should emphasize that the tests offer only weak support for the convergence hypothesis. None of the eight commodities and none of the more than two dozen city pairs yielded the result of convergence in all tests. In fact, the results provide greater support for the no-convergence hypothesis. Most of the tests indicate no convergence in prices of rice, sugar, honey, and butter, and convergence in prices of soap, the only nonfood item in the sample. There is only partial support for some convergence in wheat and olive oil prices.

Conclusion

There is some evidence that parts of Europe were becoming more integrated within themselves and with other parts of the continent during the early modern era. Even though transportation costs did not decline significantly, market integration as measured by price dispersion did take place in different parts of western Europe during this period. It has been argued that such market integration during the early modern era was due to the the removal or lowering of a wide range of institutional and other barriers, and to increasing political centralization that increased domestic stability and reduced coordination failures between markets.

We utilized annual price series for wheat, which is often used in these studies, and for seven additional commodities from eight cities around the Mediterranean and in northern and central Europe to study the integration of these long-distance and mostly international markets as measured by price convergence. We employed a number of additional methodologies as well as the frequently used coefficient of variation. Admittedly, our statistical tests for convergence were more demanding than simply looking at the coefficient of variation over time. The results do not provide support for the hypothesis that price convergence occurred as a permanent trend between these markets during the early modern centuries. While there are differences in the results based on alternative methodologies, the tests provide greater support for the no-convergence hypothesis. The differences in the results from alternative techniques also suggest that drawing inferences from data about price convergence is not a methodologically simple enterprise.

It would have been interesting to explore the extent to which regional variations in patterns of market integration might have existed in early modern Europe. Unfortunately, since very few of the pairs of cities actually indicate convergence in the cointegration tests, a regional pattern is not immediately obvious. At this point, we also should note that the Mediterranean is strongly represented in our data. If long-distance markets around the Mediterranean experienced less market integration than other regions of Europe during the early modern era, it is possible that the data is biased in this respect. Hopefully, larger and geographically more representative data sets will allow for more nuanced answers to this and other questions in the future.

Although maritime trade and overseas discoveries have often loomed large in explanations of the late medieval recovery and European ascendancy, the body of evidence we have gathered cannot sustain a blanket conclusion that the integration of long-distance markets across Europe was a significant trend during the early modern era. Our results suggest, instead, not only that transportation costs did not decline but that, despite some exceptions, political and institutional changes did not have a significant effect on long-distance and international trade before the nineteenth century. In the absence of any decline in transportation costs or institutional barriers such as tariffs or national borders, the increases in the volume of long-distance trade during the early modern era must have been due to shifts in demand or supply, and to increases in incomes.

The absence of price convergence and market integration in long-distance and international trade should not mean the end of the concept of market integration, however. We would argue for a distinction between long-distance trade, on the one hand, and short- and medium-range trade, on the other. Trade in Europe, and for that matter around the globe, was still mostly regional and domestic before and even well into the nineteenth century. For most countries, the volume of long-distance trade was still small in comparison to domestic or regional trade before 1800. Our results suggest strongly that market integration did not apply to long-distance trade during this period. Price convergence and market integration may have occurred in some short- and medium-range trade thanks to institutional changes in parts of Europe. In other words, market integration and Smithian growth need to be considered mostly in connection with short- and medium-range domestic or regional trade in early modern Europe.

Notes

1. Persson (1999, 98–100) also provides evidence of increased regional integration of wheat markets during the sixteenth and seventeenth centuries in Tuscany, and between Tuscany and southern France, but not inside France.

2. The price data for Istanbul were obtained from Şevket Pamuk, ⟨http://www.iisg.nl/hpw/data.php#ottoman⟩. Data for Modeno, Paris, Vienna, and Sopron are from the Global Price and Income History Group data set, ⟨http//gpih.ucdavis.edu/⟩. Data for Madrid and Barcelona were originally gathered by Earl Hamilton; they have since been updated by Feliu and Montfort. Data for western Netherlands were obtained from Jan Luiten van Zanden, ⟨http://www.iisg.nl/hpw/data.php⟩, and data for southern England from Bob Allen. We are pleased to acknowledge the support of these groups and individuals.

3. O'Rourke and Williamson (2002a; 2002b) are a significant exception.

4. The convergence literature relies heavily on the income convergence concept introduced by Baumol (1986), and Barro and Sala-i-Martin (1992; 1995). Using cross-country data, researchers of the economics of growth indicated that growth in the ratio of incomes in two countries is negatively related to the ratio of incomes at the base period. As a result of this finding, they concluded that the difference between per capita incomes is expected to diminish in time. This is called beta convergence. However, researchers do not solely rely on beta convergence. Sigma convergence, which is defined as the standard deviation of incomes at a given period, is also utilized. Variation of incomes among various countries, measured as the standard deviation, should also decrease in time to conclude that there is convergence of incomes. There are many critics of the method, and almost as many alternatives or variants, for example, Quah (1993; 1996), Linden (2002), Johnson (2000), and Rassekh, Panik, and Kolluri (2001).

5. There are two practical issues in performing a unit root test: first, the choice of including a constant, a constant and a linear time trend, or neither, in the test regression; and second, the specification of the number of lagged difference terms to be added to the test regression. A constant is used in the test regression. The number of lags is determined using Akaike and Schwartz criteria. MacKinnon (1991) critical value calculations are used in performing ADF and PP tests. *Eviews* software by Quantitative Micro Software QMS (2005) is used in our calculations.

6. It should be noted that the null hypothesis of a nonstationary series cannot be rejected at the 5 percent level of significance, according to the ADF and PP tests. The probability significance associated with −2.59 in the ADF is .095, and .098 for −2.58 in the PP, very close to .10 for the rejection of the null nonstationary but far from the probability of .05. In other words, one can argue that the conclusion at the 5 percent level of significance is failure to reject the null, therefore nonstationary, indicating convergence. At the 5 percent level of significance, the conclusion based on these two tests is that there is convergence in prices. The critical levels for the KPSS test are 0.347 for the 10 percent level of significance, 0.463 for the 5 percent level of significance, and 0.739 for the 1 percent level of significance. The calculated 0.28 is far below these and not large enough to reject the null, in this test, stationary. Therefore, the KPSS test is closer to the no-convergence conclusion than the other two.

7. With a test statistic of 1.37.

8. Very close in the ADF test, with a significance level of .0533.

9. Also Carlino and Mills (1993), Ewing and Harter (2000), Haldane and Hall (1991), Hall, Robertson, and Wickens (1997), St. Aubyn (1999), and Trivez (2001).

10. For an earlier version of the study presented at the Harvard conference, we had conducted unit root tests for the ratios of prices, which is almost equivalent to testing for cointegration of prices with a coefficient of 1. Results obtained in the two versions are similar. Moreover, multiple unit root tests, panel tests, that were conducted in the earlier version also indicated no convergence in prices. Panel-based unit root tests, which may have higher power, differ in the assumption regarding the persistence parameters. Im, Pesaran, and Shin (2003), Fisher-ADF, and Fisher-PP tests allow the persistence parameters to vary freely across cross-sections. The latter two are based on the idea that a test statistic may be derived from an individual test, suggested by Fisher (1932) and proposed by Maddala and Wu (1999) and Choi (2001). On the other hand, Levin, Lin, and Chu (2002), Breitung (2000), and Hadri (2000) assume a parameter common across cross-sections. The Hadri test is similar to the KPSS test for a single series.

11. Critical values provided by Davidson and MacKinnon (1993, 772) need to be used in this case because the test is not applied to an original time series but to a series of residuals that is estimated from a regression. For tests with a constant, these critical values are 1 percent, −3.90; 5 percent, −3.34; and 10 percent, −3.04.

12. In this case, critical values from Davidson and MacKinnon are used rather than the critical values for the D-F test. The calculated value of −0.85 is smaller in absolute value than the critical value of −3.4.

13. The test can be conducted using the maximum eigenvalue or trace statistics. Both statistics were developed by Johansen (1988). *Eviews* software by Quantitative Micro Software QMS (2005), which is used here, provides critical values published by MacKinnon, Haug, and Michelis (1999).

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